# Economics of production of channel catfish, *ictalurus punctatus*, female x blue catfish, *I. furcatus*, male hybrid fingerlings and foodfish

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## Abstract

The profitability of the channel-blue hybrid catfish fingerlings and foodfish was compared to that of the channel catfish using enterprise budgets and sensitivity analyses. Average total costs of production were 15.0-22.5 per cent less for hybrids fingerlings, even if hybrid fry were bought at a price twice as high as that for channel catfish. Average total costs were $33.00 per 1000 fingerlings and $44.00 per 1,000 fingerlings for hybrid and channel catfish fingerlings, respectively. The net returns to land, labor, and management were $15,020.00 per hectare ($6008.00/acre), and $3,710.00 per hectare ($1484.00/acre) for hybrid and channel catfish foodfish production, respectively, assuming selling prices of $130 per thousand and $100 per thousand, respectively. Sensitivity analyses indicated that farm price had the largest effect on net profits, followed by feed conversion and feed price, with fingerling price having the smallest effect on net profits among these variables for hybrid catfish, foodfish production.

*Keywords*: hybrid catfish, fingerlings, foodfish, profitability

## Introduction

Above average returns from investment in catfish production in the 80s encouraged producers and input providers to enter the catfish industry. From 1983 to 1993 catfish production increased by 234 per cent (USDA 2000; Kinnucan 1995; Jolly et al: 1998). Reduced net margins in the 1990s, due to increased production costs (Engle & Kouka 1996), have motivated farmers, input providers, market participants, administrators, and researchers to seek alternatives to increase catfish production and market efficiency through reduction in per-unit production cost. Catfish

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market participants have introduced new husbandry techniques in order to expand output. Promotional efforts have been made by the Catfish Farmers of America and the Catfish Institute to increase consumer demand. On the research side scientists have been evaluating genetically improved strains of channel catfish to obtain a fish with superior traits.

This hybrid is produced by crossing the channel catfish female (*Ictalurus punctatus*)x blue catfish male (*Ictalurus furcatus*). The channel-blue (CB) hybrid exhibits faster growth rates, better feed conversion, tolerance to low oxygen, increased resistance to diseases, tolerance to crowded growth conditions, uniformity in size and shape, higher dress-out percentages, and increased harvestability and seining (Masser and Dunham 1998). Heterosis for growth (increased vigor or capacity for growth from crossbreeding of genetically different animals) rate is affected by genotype-environment interactions, and is not always observed during the fingerling growth phase. Heterosis for survival and disease resistance is usually obtained during the fingerling phase. Research has shown that CB hybrid or CB hybrids show an increase in feed efficiency of 8.5 to 10 per cent (Dunham et al. 2000). Though the production of CB hybrid has been shown experimentally to have marketable traits, financial evaluation of the CB hybrid foodfish production must be made at the farm level, and for adoption to take place the information disseminated at the farm level.

Few attempts have been made to evaluate catfish fingerling production enterprises. Hebicha (1984) found that channel catfish fingerling production generated positive returns above all costs. Hatch et al. (1987), using enterprise budgeting and linear programming, found that channel catfish fingerling production was a profitable farm enterprise, and competed well with egg, fry, and food-size fish production as alternative enterprises for water hectares, and that farmers did not respond to marginal changes in fingerling prices. Hatch et al. (1989) also showed that channel catfish fingerling production was the most profitable enterprise when compared to the production of eggs, fry, and food-size fish production, but the dispersion of expected income was also the highest. Whereas channel catfish fingerling production has shown much promise, not much is known about the profitability of the CB hybrid fingerlings and foodfish production. It is expected that if farmers perceive a set of advantages in CB hybrid fingerling and food fish production, they may embrace this new technology. The CB hybrid will reduce the fingerling size variability problem and present a viable alternative for bolstering farm income.

In this paper, the economic and financial viability of the fingerling and food-size fish production will be studied. Enterprise budgeting technique will be used to evaluate short term profitability. Capital budgeting will be used to compare the long run profitability of CB hybrid production to that of channel catfish. Risk analysis will determine financial soundness of this new innovation.

## Materials and Methods

### 1) Fingerling production

The ponds were all dug-out ponds and were filled with well water. Maintenance and repair of equipment costs used for the production and growing of hybrids were charged as a percentage, between 2 and 10 per cent, of the original operating cost of items used for the production process of the hybrid catfish and channel catfish.

It was assumed in the different fingerling budgets that land was owned by the farmers, but that the ponds needed to be built. The nursery pond was drained to release water accumulated during the waiting period before stocking the 10-day-old fry. This was done to eliminate unwanted organisms, insects, and wild fish. A one-hectare (2.5 acres) pond with a depth of 1.5

m (5 feet) used 15,000 $m^3$ (12.5 acre feet) of water. The price of one cubic meter of water was estimated to be $0.006 (Tieman *1995*).

After six days in the rearing trough, the fry were moved to nursing ponds. The fry were stocked in a one-hectare (2.5 acre) nursery pond at a density of 250,000 fry per hectare (100,000 fry/acre), and were grown to 16.25 cm (6.5 inches). The weight of 1,000 10-day-old fry was 44 grams or 1.57 ounces (Hebicha 1984), while the weight of one 16.25-cm (6.5-inch) fingerling was 35 grams (0.08 lbs.). The fry were fed over a period of 150-180 days during the fall of 1996. The feed conversion during this period for the hybrid fingerling was 1.5 while the channel catfish fingerling had a feed conversion of 1.8. The mortality rate for the hybrid fingerlings was 12 per cent while the channel catfish had a mortality rate of 39 per cent (Table 1).

**Table 1** Production parameters for hybrid and channel catfish fingerlings

| Research | Specie Produce | Fry Stocking | Fingerling Survival % | Feed conversion |
|---|---|---|---|---|
| Gold Kist[1,2] | Hybrid Catfish | 250,000/ha | 88 ± 12 | 1.48 ± 0.19 |
| Gold Kist[1,2] | Channel Catfish | 250,000/ha | 61 ± 18 | 1.81 ± 0.41 |
| Tiemen (1995)[3] | Hybrid Catfish | 625,000/ha | 55 | 1.60 ± 0.56 |
| Tiemen (1995)[3] | Channel Catfish | 600,000/ha | 48 | 1.72 ± 0.27 |

[1] Data collected from Gold Kist Farm, Inverness, Mississippi
[2] Data used in current study
[3] Data collected at Auburn University (see References).

Labor was paid $6.56 per hour. Feeding and maintenance of the fish in the nursery pond needed 80 hours of labor for one hectare (2.5 acres) for 180 growing days (Hebicha 1984). On average, 13 hours of labor were needed for chemical application per hectare per year (5.2 hours/acre/year). To stock 250,000 fry per hectare (100,000 fry/acre), 4.35 hours per ha (1.74 hours/acre) of labor were needed (Hebicha 1984). Harvesting of 9,091 kg (20,000 pounds) of fingerlings, required 80 hours of labor (Hebicha 1984). The price for the CB hybrid fingerlings in the budgets was $130 per 1,000 fingerlings, while the channel catfish fingerlings were sold for $100 per1,000. The feed price for the fingerlings budgets was estimated at $222 per ton.

Electricity was used for the hatching trough and for aerators in the fingerling ponds. The hatching troughs had a gear motor that was used to turn the paddles of the hatching troughs. Each kilowatt-hour (KWH) of electricity was charged $0.09 in the different budgets. Electricity for the nursery ponds was mainly used for aerators to provide oxygen to the fish in the ponds. The operating time of an aerator in the grow-out ponds was assumed to average six hours for 180 days starting in May. The total time requirement is based on a rate of one kilowatt per horsepower per hour (Crews et al. 1992).

Operating capital used in the different budgets for producing and growing hybrids was charged 9 per cent over the production period. The interest on the hatchery, equipment, machinery, and ponds was charged over the whole year. The interest rate used for the ownership costs was 10 per cent.

The straight- line depreciation method was used. Salvage value was assumed to be 10 per cent of the original cost of the equipment and hatchery. Depreciation was calculated on an annual basis. Depreciation of brood stock was calculated as the annual replacement of brood stock due to a 15 per cent mortality (Hebicha 1984). An available market for the hybrid fingerlings was assumed. The point of sale of fingerlings was at the farmgate. All costs during these transactions were charged to the farmer who sold these products.

### 2) Foodfish production

The grow-out ponds were stocked in December with 6.5-inch of CB hybrid and channel catfish fingerlings, with an average weight of 35 grams (0.077 lbs.), and were harvested the following fall (September) when the fish reached 0.582 kg (1.28 lbs.) on average. The stocking density was 15,250 fingerlings per hectare (6,100 fingerlings/acre), and the pond size was 3.4 hectares (8.5 acres). The feed conversion ratio for the hybrid catfish and channel catfish were, respectively, 1.9 and 2.0 (Table 2). The estimated mortality rate for hybrid and channel catfish were 12 per cent and 17 per cent (Table 2). The fingerlings stocked in the grow-out pond were fed to satiation with a 32 per cent crude protein feed. Medicated feed (terramycin) was used as prophylactic against bacterial diseases for a 10-day period. Feeding was done by a tractor or truck equipped with a feeder-blower.

**Table 2** Production parameters for hybrid and channel catfish food-size

| Hybrid Catfish | | | | | |
|---|---|---|---|---|---|
| **Source** | **Mean Weight Fingerlings (kg)** | **Stocking Density (# Fingerlings/ha)** | **Survival Rate (%)** | **Feed Conversion Ratio** | **Yield (kg/ha)** |
| Auburn Fisheries Station | 0.056 | 15,330 | 92 | 1.46 | 5,473 |
| Auburn Fisheries Station | 0.023 | 11,233 | 97 | 1.41 | 6,194 |
| Jeppsen[1] | 0.083 | 12,500 | 89 | 1.91 | 11,578 |
| Jeppsen[1] | 0.084 | 12,500 | 84 | 2.00 | 9,431 |
| Jeppsen[1] | 0.088 | 12,500 | 87 | 1.83 | 9,588 |
| Daniel Clemmer[2] | 0.062 | 13,355 | 83 | 2.17 | 11,211 |
| Gold Kist[3,8] | 0.033 | 14,951 | 88 | 1.88 | 8,028 |
| Gold Kist[3,8] | 0.035 | 15,128 | 90 | 1.83 | 7,711 |
| Straight Creek[4] | 0.035 | 19,883 | 100 | 1.90 | 7,775 |
| Straight Creek[4] | 0.038 | 18,365 | 100 | 1.97 | 7,751 |
| Lester Meyers[5] | 0.047 | 18,571 | 99 | 2.15 | 10,351 |
| **Channel Catfish** | | | | | |
| **Source** | **Mean Weight Fingerlings (kg)** | **Stocking Density (# Fingerlings/ha)** | **Survival Rate (%)** | **Feed Conversion Ratio** | **Yield (kg/ha)** |
| Gold Kist[3,7,8] | 0.046 ± 0.005 | 15,254 ± 297 | 83 ± 13 | 1.95 ± 0.34 | 7,579 ± 1,260 |
| Tucker and Robinson[6] | 0.027 - 0.036 | 12,500 -15,000 | 82 | 2.25 | 6,818 - 7,955 |

[1] Data collected at Auburn University (see References).
[2] Data collected at a farm in Uniontown, Alabama.
[3] Data collected at Gold Kist, Inverness Mississippi.
[4] Data collected at a farm in Inverness, Mississippi.
[5] Data collected at a farm in Mississippi.
[6] Average values from the catfish industry (see References).
[7] The channel catfish data came from fish that were selected for faster growth and larger body weight.
[8] Production parameters used in this study.

## Baseline Assumptions

It was assumed in the different budgets that land was owned by the farmers, but that the ponds needed to be built. Ponds were dug and filled with water from natural rainfall. A single batch system was used. Ponds were seined, not drained.

The farmer supplied all routine management and labor, while additional labor could be hired for monitoring dissolved oxygen and for other activities, such as stocking fingerlings and other maintenance activity. In these budgets, it was assumed that labor was paid $6.56 per hour. The minimum wage is $5.25 per hour, but it was assumed that these workers had some skills and demanded slightly higher wages.

## Financial and economic

Relevant information from previously developed budgets and research papers, together with new research information from the Gold Kist Catfish Genetics Research Farm and from the Auburn University Catfish Genetics Research Unit (Tables 1 and 2), were used to develop and update budgets for the production of fingerlings and food-size fish for both channel and hybrid catfish.

The interest, maintenance, and equipment repair costs for the production and growing of hybrids were the same as that of the fingerling production. Operating capital cost was charged the same for fingerlings. Electricity was used for the aerators in the grow-out ponds. Each kilowatt-hour (KWH) of electricity was charged $0.09 in the different budgets. Electricity for the grow-out ponds was mainly used for aerators to provide oxygen to the fish in the ponds. It was assumed that the operating time of an aerator in the grow-out ponds is on average six hours for 180 days with starting date in May. The total time requirement is based on a rate of one kilowatt per horsepower per hour (Crews et al. 1992).

The straight-line method of depreciation was used. Salvage value was assumed to be 10 per cent of the original cost of the equipment and hatchery. Depreciation was calculated on an annual basis. Depreciation of brood stock was calculated as the annual replacement of brood stock due to a 15 per cent mortality (Hebicha 1984).

It was assumed that markets for the hybrid food-size fish were available. The food-size fish were harvested by the processor during the fall. The point of sale was at the farm and hatchery. All costs during these transactions were charged to the farmer who sold these products.

*Capital budgeting* or investment analysis was used to evaluate the economic and financial feasibility of the project (investment in CB hybrid fingerlings and foodfish production or channel catfish fingerlings and foodfish production). The total capital required to establish two and four hectares (five and 10 acres) of CB hybrid and channel catfish were estimated. Cost and return figures for a period of 10 years were obtained from the enterprise budgets. Constant costs and returns were assumed for each of the projects. The net cash inflows were discounted using a 9 per cent discount rate and subtracted from the initial costs to obtain the net present values (NPVs). The internal rate of return (IRR), which is the interest rate that equates the NPV of the projected series of cash inflows to zero, was calculated. The profitability index, which is the net present value of the series of cash inflows divided by the initial investment, was also calculated.

## Risk analysis

Risk analysis was conducted by manipulation of a set of key parameters to determine whether changes in those parameters such as price of feed, feed efficiency rates, price of output, mortality rates, and other prices of inputs would affect the investments in CB hybrid. A Monte Carlo simulation procedure of the computer program @RISK was used to compare the uncertainty of investment in CB hybrid with that of channel catfish. This simulation was used to calculate the expected returns above costs and the NPV of each investment and the associated risks. The parameters used in the development of the risks models are seen in Tables 1, 2, and 3.

## Results

### Results for Fingerling production

*Budget analysis*

The production of 0.4 hectare (one acre) of CB hybrid fingerlings was profitable in the short run. For 0.4 hectare (one acre), the CB hybrid fingerlings generated $6,009.01 net returns to land and management (Table 3). The per unit total cost was $61.73. The fixed costs made up 39 per cent of all costs. Feed and the cost of fry were the most significant cost components. Feed and the cost of fry together made up 75 per cent of variable cost and 46 per cent of all costs.

**Table 3** Budget for producing hybrid fingerlings using 0.4-hectare (1-acre) pond and a stocking density of 250,000 fry per hectare (100,000 fry/acre), with feed conversion of 1.48 and a mortality rate of 12%

| Items | Unit | Price/Unit ($) | Quantity | Value/Costs ($) |
|---|---|---|---|---|
| **Gross receipts** | | | | |
| Fingerlings | thousand | 130.00 | 88.00 | 11,440.00 |
| **Variable cost** | | | | |
| Fry | thousand | 15.00 | 100.00 | 1,500.00 |
| Feed | ton | 221.97 | 4.76 | 1,056.57 |
| Labor | hour | 6.56 | 19 | 124.64 |
| Maintenance & repair | $ | | | 283.61 |
| Fuel & oil | $ | | | 116.86 |
| Ground water | $m^3$ | 0.006 | 6,000 | 36.01 |
| Interest on operational cap. | $ | 0.09 | 3,118.58 | 280.67 |
| **Total Variable Costs** | $ | | | 3,398.36 |
| **Income above variable costs** | $ | | | 8,041.64 |
| **Fixed costs** | $ | | | |
| Depreciation equipment | $ | | | 777.50 |
| Interest on ownership cost | $ | 0.10 | | 1,255.13 |
| **Total Fixed Cost** | $ | | | 2,032.63 |
| **Total Cost** | | | | 5,430.99 |
| **Net returns to land and management** | $ | | | 6,009.01 |
| Break-even cost | $ | | | |
| To total cost | $ | | | 62.71 |
| To fixed cost | $ | | | 23.10 |
| To variable cost | $ | | | 38.61 |
| **NPV** | $ | | | 5,459.25 |
| **IRR** | % | | | 15.59% |
| **PI** | | | | 1.26 |

The higher the survival rate for the CB hybrid compared to the channel catfish fingerlings, the lower the price to cover cost ($61.73) for 1,000 fingerlings compared to $75.67 for the same number of channel catfish fingerlings. For 0.4 hectare (one acre) of CB hybrid the unit price to cover operating costs was $38.63. This compares to $42.34 for operating costs for the channel catfish.

Feed costs were the same for the CB hybrid and the channel catfish despite the differential in feed conversion ratios, which was 1.48 for the CB hybrid and 1.73 for the channel catfish. The net returns to land, labor, and management for the CB hybrid for the same size of operation was four times that of the channel catfish. The net returns to land, labor, and management for the CB hybrid was $6,009.01 while that of the channel catfish was $1,484.42 (Table 4). While the cost items were similar, the differential in net returns to land, labor, and management resulted from higher survival rates for the CB hybrid.

**Table 4** Budget for producing channel catfish fingerlings using 0.4-hectare (1-acre) pond and a stocking density of 250,000 fry per hectare (100,000 fry/acre), with feed conversion of 1.81 and a mortality rate of 39%

| Items | Unit | Price/Unit ($) | Quantity | Value/Costs ($) |
|---|---|---|---|---|
| **Gross receipts** | | | | |
| *Fingerlings* | *thousand* | *100.00* | *61.00* | *6,100.00* |
| **Variable cost** | | | | |
| Fry | thousand | 7.50 | 100.00 | 750.00 |
| Feed | ton | 221.97 | 4.76 | 1057.20 |
| Labor | hour | 6.56 | 19.00 | 124.11 |
| Maintenance & repair | $ | | | 283.61 |
| Fuel & oil | $ | | | 116.86 |
| Ground water | $m^3$ | 0.006 | 6000.00 | 37.90 |
| Interest on operational cap. | $ | 0.09 | 2369.68 | 213.27 |
| **Total Variable Costs** | $ | | | 2582.95 |
| **Income above variable costs** | $ | | | 3517.05 |
| **Fixed costs** | $ | | | |
| Depreciation equipment | $ | | | 777.50 |
| Interest on ownership cost | $ | *0.10* | | 1255.13 |
| **Total Fixed Cost** | $ | | | 2032.63 |
| **Net returns to land and management** | $ | | | 1484.42 |
| **Break-even cost** | $ | | | |
| To total cost | $ | | | 75.67 |
| To fixed cost | $ | | | 33.32 |
| To variable cost | $ | | | 42.34 |
| **NPV** | $ | | | -10621.18 |
| **IRR** | % | | | -6.95% |
| **PI** | | | | 0.49 |

*Capital budgeting for fingerlings*

The long run investment in facilities for the production of 0.4 hectare (one acre) of CB hybrid generated an IRR of 15.59 per cent. The planning horizon was 10 years and the discount rate was 10 per cent. This means that at cost of capital of 10 per cent, 0.4 hectare of CB hybrid is able pay for the present cost of capital. The profitability index is 1.26. While it is profitable to

produce 0.4 hectare of channel catfish fingerlings in the short run, it is not profitable to borrow fixed capital to invest in this size of operation when the discount rate is 10 per cent. When the long term profitability of one hectare (2.5 acres) CB hybrid facility for fingerling production is compared to that of the channel catfish we observed that, though the channel catfish fingerling enterprise required same fixed investment of $22,629.82 as the CB hybrid, the IRR for the CB hybrid was much higher, 42.68 per cent, compared to 17.96 per cent for the channel catfish fingerling production. The profitability index was 3.17 for the CB hybrid investment and only 1.39 for the channel catfish fingerling production (Table 5). This means that the discounted returns are 3.17 times the initial investment for hybrid catfish and 1.39 for channel catfish.

**Table 5** Budget for producing hybrid and channel catfish fingerlings using 1-hectare (2.5-acre) pond and a stocking density of 250,000 fry per hectare (100,000 fry/acre)

| | Hybrid Catfish | Channel Catfish |
|---|---|---|
| | feed conversion 1.48 | feed conversion 1.73 |
| | mortality 12% | mortality 39% |
| | price thousands fingerlings $130 | price thousands fingerlings $100 |
| **Items** | value/costs ($) | value/costs ($) |
| **Gross receipts for fingerlings** | 28,600.00 | 15,250.00 |
| **Total Variable Costs** | 7,845.32 | 5,804.56 |
| **Income above variable costs** | 20,754.68 | 9,445.44 |
| **Total Fixed Cost** | 2,212.63 | 2,212.63 |
| **Net returns to land and management** | 18,542.05 | 7,232.81 |
| **Break-even cost per thousand fingerlings** | | |
| **To total cost** | 45.72 | 52.57 |
| **To fixed cost** | 10.06 | 14.51 |
| **To variable cost** | 35.66 | 38.06 |
| **NPV** | 49,017.20 | 8,816.14 |
| **IRR** | 42.68% | 17.96% |
| **PI** | 3.17 | 1.39 |

*Sensitivity analysis for fingerlings*

The profitability of production of CB hybrid fingerlings is superior to that of the channel catfish. However, before farmers engage in CB hybrid production, information on sensitivity of net returns to changes in critical parameters should be provided. It is important to determine whether the enterprise is still profitable if costs change.

The profitability of the CB hybrid fingerling production using a one-hectare (2.5-acre) unit was not seriously affected by a 10, 20, or 30 per cent increase in variable cost. With an increase in variable cost of 30 per cent, the net returns to land and management decreased by 12.5 per cent, and the net present value was reduced by 16.6 per cent (Table 6). This means that even with a 30 per cent increase in production cost of CB hybrid, the venture is still profitable in the short and long runs. An increase in feed price of 10, 20, and 30 per cent only reduced the profitability of the one-hectare (2.5-acre) CB fingerling producing unit by 1.5, 2.9, and 4.4 per

cent. The 10, 20, and 30 per cent change in the feed cost had only reduced the profitability index slightly from 3.19 to 3.15, 3.10, and finally to 3.06. Investment in CB hybrid is a sound undertaking that may not result in failure with slight changes in market conditions.

**Table 6** Sensitivity analysis for 1-hectare (2.5 acres) hybrid fingerling and 4 hectare (10 acres) of hybrid foodsize-fish

**Sensitivity analysis for the hybrid fingerlings budget by changing variable cost, feed price, fry price, fingerling price with 10, 20, and 30%, and the effects on net returns, variable cost, tc, IRR, PI**

| % change | var.cost ($) | net returns ($) | var. cost ($) | tc ($) | IRR | PI |
|---|---|---|---|---|---|---|
| | 7,693.79 | 18,693.58 | | 45.03 | 0.43 | 3.2 |
| 10 | 8,463.17 | 17,924.20 | | 48.53 | 0.42 | 3.1 |
| 20 | 9,232.55 | 17,154.82 | | 52.02 | 0.40 | 2.9 |
| 30 | 10,001.93 | 16,385.44 | | 55.52 | 0.39 | 2.8 |
| | **feed price ($/ton)** | **net returns ($)** | **var. cost ($)** | **tc ($)** | **IRR** | **PI** |
| | 221.97 | 18,693.58 | 7,693.79 | 45.03 | 0.43 | 3.2 |
| 10 | 244.17 | 18,420.91 | 7,966.46 | 46.27 | 0.42 | 3.2 |
| 20 | 266.37 | 18,148.23 | 8,239.14 | 47.51 | 0.42 | 3.1 |
| 30 | 288.56 | 17,875.67 | 8,511.70 | 48.75 | 0.41 | 3.1 |
| | **fry price ($/1000)** | **net returns ($)** | **var. cost ($)** | **tc ($)** | **IRR** | **PI** |
| | 15.00 | 18,693.58 | 7,693.79 | 45.03 | 0.43 | 3.2 |
| 10 | 16.50 | 18,284.83 | 8,102.54 | 46.89 | 0.42 | 3.1 |
| 20 | 18.00 | 17,876.08 | 8,511.29 | 48.75 | 0.41 | 3.1 |
| 30 | 19.50 | 17,467.33 | 8,920.04 | 50.60 | 0.41 | 3.0 |
| | **fing price ($/1000)** | **net returns ($)** | **var. cost ($)** | **tc ($)** | **IRR** | **PI** |
| | 130.00 | 18,693.58 | 7,693.79 | 45.03 | 0.43 | 3.2 |
| 10 | 143.00 | 21,553.58 | 7,693.79 | 45.03 | 0.48 | 3.6 |
| 20 | 156.00 | 24,413.58 | 7,693.79 | 45.03 | 0.53 | 4.1 |
| 30 | 169.00 | 27,273.58 | 7,693.79 | 45.03 | 0.57 | 4.5 |

**Sensitivity analysis for the hybrid food size fish budget by changing variable cost, feed conversion, feed price, fingerling price, farm price with 10, 20, and 30%, and the effects on net returns, variable cost, tcf, IRR, PI**

| % change | var.cost ($) | net returns ($) | | tc | IRR | PI |
|---|---|---|---|---|---|---|
| | 27,861.82 | 16,132.07 | | 0.47 | 42.87% | 3.30 |
| 10 | 29,326.00 | 14,667.89 | | 0.49 | 40.39% | 3.10 |
| 20 | 31,992.00 | 12,001.89 | | 0.53 | 35.63% | 2.70 |
| 30 | 34,658.00 | 9,335.89 | | 0.56 | 30.51% | 2.30 |
| **% change** | **feed price ($)** | **net returns ($)** | **var.cost ($)** | **tcf** | **IRR** | **PI** |
| | 250.00 | 16,132.07 | 27,861.82 | 0.47 | 42.87% | 3.30 |
| 10 | 275.00 | 14,673.96 | 29,319.93 | 0.49 | 40.40% | 3.10 |
| 20 | 300.00 | 13,215.85 | 30,778.04 | 0.51 | 37.84% | 2.80 |
| 30 | 325.00 | 11,757.74 | 32,236.15 | 0.53 | 35.18% | 2.60 |
| **% change** | **fingerling price ($)** | **net returns ($)** | **var.cost ($)** | **tcf** | **IRR** | **PI** |
| | 0.13 | 16,132.07 | 27,861.82 | 0.47 | 42.87% | 3.30 |
| 10 | 0.14 | 15,461.07 | 28,532.82 | 0.48 | 41.74% | 3.20 |
| 20 | 0.16 | 14,387.47 | 29,606.42 | 0.49 | 39.90% | 3.00 |
| 30 | 0.17 | 13,515.17 | 30,478.72 | 0.50 | 38.37% | 2.90 |
| **% change** | **farm price ($)** | **net returns ($)** | **var.cost ($)** | **tcf** | **IRR** | **PI** |
| | 0.70 | 16,132.07 | 27,861.82 | 0.47 | 42.87% | 3.30 |
| 10 | 0.77 | 20,947.81 | 27,861.82 | 0.47 | 50.51% | 4.00 |
| 20 | 0.84 | 25,763.55 | 27,861.82 | 0.47 | — | 4.70 |
| 30 | 0.91 | 30,579.29 | 27,861.82 | 0.47 | — | 5.40 |

*Note*: tc = total cost per 1,000 fingerlings, tcf = total cost per kg of foodfish, IRR = internal rate of return, PI = profit index.

*Risk analyses for fingerlings*

The CB hybrid showed risk dominance over the channel catfish fingerlings for risk levels lower than 75 per cent. In the long run there was a 25 per cent probability of making negative NPV in the production of channel catfish fingerlings, but nearly a zero chance for CB hybrid at the stated market price. The CB hybrid is risk superior to channel catfish fingerlings for these ranges (0-75 per cent) of risks (Figure 1). At higher risk levels the channel catfish fingerling production dominated. For long term investments, as shown by the riskiness associated by NPV in Figure 1, the channel catfish had a 25 per cent chance of generating negative NPV, while the CB hybrid had almost a zero chance of making negative NPV, all things remaining constant. CB hybrid fingerling production showed superior income-risk relationships for probability levels up to 75 per cent, and from then on the channel catfish dominated.

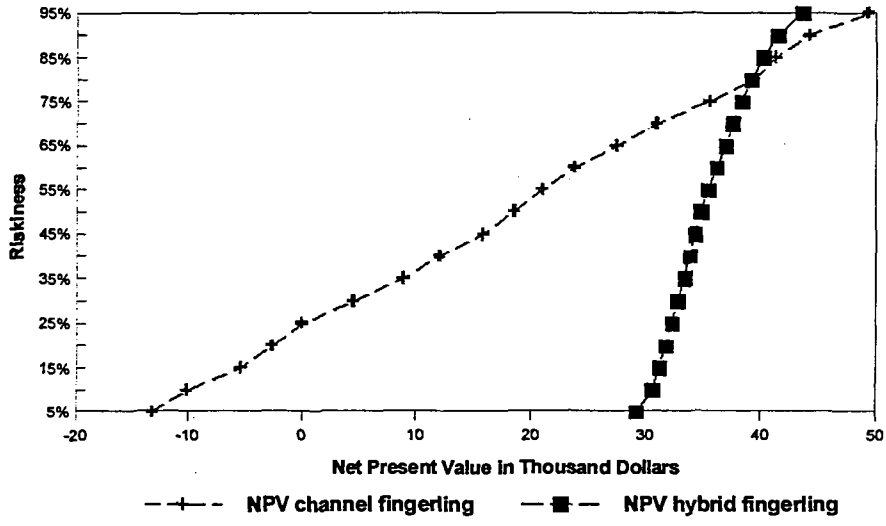


**Figure 1** Riskiness and net present value for 1 hectare (2.5 acres) of hybrid and channel catfish fingerlings

## Results for production of food size fish

The production of food-size fish using CB hybrid and a four-hectare (10-acre) facility required annualized variable costs of $27,861.82 and annualized fixed costs of $4,163.51 (Table 7). The operating cost for food-sized channel catfish production was $25,989.11 and the fixed annual capital requirement was $4,163.51 (Table 8). The unit total cost for this production level of CB hybrid is $1.01 per kg ($0.46/pound) with $0.88 ($0.40/pound) going to variable costs and $0.13 ($0.06/pound) allocated to fixed costs compared to $1.03 ($0.47/pound) per total unit cost for the channel catfish. The difference in total unit cost was due to higher survival rates obtained for the CB hybrid, 88 per cent compared to 83 per cent for the channel catfish. From this difference of $0.01 in per-unit cost, one can infer that the CB hybrid producer is slightly more competitive on the market than the channel catfish producer. This translates into an additional $1,373.86 per four hectare (10 acres) CB hybrid pond produced under the same production system as proposed in Table 7. The CB hybrid producer is also more cost effective in producing food sized fish than the channel catfish producer. A dollar invested in CB hybrid production generates $0.50 net returns to land and management compared to $0.48 for the channel catfish.

**Table 7** Budget for producing 0.581 kg (1.28 lbs.) of CB hybrid catfish food size fish using 4-hectare (10-acre) pond and a stocking density of 15,250 fingerlings per hectare (6,100 fingerlings/acre), with an average fingerling weight of 0.035 kg (0.077 lbs.), feed conversion of 1.86, and mortality rate of 12 per cent

| Items | Unit | Price/Unit ($) | Quantity | Value/Costs ($) |
|---|---|---|---|---|
| **Gross receipts** | | | | |
| Catfish | kg | 1.54 | 31,271.04 | 48,157.40 |
| | | | | |
| **Variable cost** | | | | |
| Fingerling | each | 0.13 | 61,000.00 | 7,930.00 |
| Feed | ton | 250.00 | 53.02 | 13,255.53 |
| Chemicals | | | | 80.00 |
| Labor | hr | 5.50 | 280.40 | 1,542.20 |
| Tractor/truck (fuel, etc.) | hr | 5.13 | 93.00 | 477.09 |
| Electricity | kwh | 0.09 | 16,200.00 | 1,458.00 |
| Miscellaneous | acre | 5.71 | 10.00 | 57.10 |
| Maintenance & repair | $ | | | 529.01 |
| Interest on operational cap. | $ | 0.10 | | 2,532.89 |
| **Total Variable Costs** | $ | | | 27,861.82 |
| | | | | |
| **Income above variable costs** | $ | | | 20,295.58 |
| | | | | |
| **Fixed costs** | | | | |
| General overhead | $ | 5.00 | 10.00 | 50.00 |
| Depreciation equipment & bldg | $ | | | 2,479.60 |
| Other fixed costs on bldg & equip | $ | | | 202.14 |
| Interest on ownership cost | $ | 0.10 | 14,317.70 | 1,431.77 |
| **Total Fixed Cost** | $ | | | 4,163.51 |
| | | | | |
| **Net returns to land and management** | $ | | | 16,132.07 |
| | | | | |
| **Break-even cost** | | | | |
| To total cost | $ | | | 0.46 |
| To fixed cost | $ | | | 0.06 |
| To variable cost | $ | | | 0.40 |
| | | | | |
| **NPV** | $ | | | 53,830.66 |
| **IRR** | % | | | 42.87% |
| **PI** | | | | 3.28 |

The production of four hectares (10 acres) of channel catfish requires the same level of investment capital, but lower levels of operating capital. The lower levels of operating capital emanate from the lower prices of channel catfish fingerlings. Feed cost in the production of the channel catfish makes up 54 per cent of the variable costs, compared to 51 per cent for the CB hybrid production.

**Table 8** Budget for producing 0.581 kg (1.28 lbs.) of channel catfish food-size fish using 4-hectare (10-acre) pond and a stocking density of 15,250 fingerlings per hectare (6,100 fingerlings/acre), with an average fingerling weight of 0.035 kg (0.077 lb.), feed conversion of 1.95, and mortality rate of 17 per cent

| Items | Unit | Price/unit ($) | Quantity | Value/Costs ($) |
|---|---|---|---|---|
| **Gross receipts** | | | | |
| Catfish | kg | 1.54 | 29,162.88 | 44,910.84 |
| **Variable cost** | | | | |
| Fingerling | each | 0.10 | 61,000.00 | 6,100.00 |
| Feed | ton | 250.00 | 53.53 | 13,383.06 |
| Chemicals | | | | 80.00 |
| Labor | hr | 5.50 | 280.40 | 1,542.20 |
| Tractor/truck (fuel, etc.) | hr | 5.13 | 93.00 | 477.09 |
| Electricity | kwh | 0.09 | 16,200.00 | 1,458.00 |
| Miscellaneous | acre | 5.71 | 10.00 | 57.10 |
| Maintenance & repair | $ | | | 529.01 |
| Interest on operational cap. | $ | 0.10 | | 2,362.65 |
| **Total Variable Costs** | $ | | | 25,989.11 |
| **Income above variable costs** | $ | | | 18,921.72 |
| **Fixed costs** | | | | |
| General overhead | $ | 5.00 | 10.00 | 50.00 |
| Depreciation equipment & bldg | $ | | | 2,479.60 |
| Other fixed costs on bldg & equip | $ | | | 202.14 |
| Interest on ownership cost | $ | 0.10 | 14,317.70 | 1,431.77 |
| **Total Fixed Cost** | $ | | | 4,163.51 |
| **Net returns to land and management** | $ | | | 14,758.21 |
| **Break-even cost** | | | | |
| To total cost | $ | | | 0.47 |
| To fixed cost | $ | | | 0.06 |
| To variable cost | $ | | | 0.41 |
| **NPV** | $ | | | 48,947.01 |
| **IRR** | % | | | 40.54% |
| **PI** | | | | 3.07 |

*Capital Budgeting*

Both the CB hybrid and the channel catfish production units showed long term profitability for four-hectares (10-acre) units. A long term investment of $14,317.70 for a 10-year planning horizon at a 10 per cent discount rate generated an IRR of 42.87 per cent. The profitability index was 3.3. For the same size channel catfish operation and investment capital, and a 10-year planning horizon, with a 10 per cent discount rate, the enterprise generated IRR of 40.54 per cent. The profitability index was 3.1.

*Sensitivity analysis for food-size fish*

The profitability of production of CB hybrid food-sized fish is superior to that of the channel catfish. However, before farmers engage in CB hybrid production, information on sensitivity of net returns to changes in critical parameters should be provided. It is important to determine whether the enterprise is still profitable if costs change.

The variable costs were increased by 10, 20, and 30 per cent, but it was still profitable to produce food-sized CB hybrids (Table 8). The returns to land and management decreased with an increase in variable costs. Feed is the most important contributor to variable costs in the production of food-sized CB hybrid. Hence it was important to determine how a 10, 20, or 30 per cent increase in feed price would influence the profitability in both the short and long term. When feed price increased from 10 to 30 per cent, the net returns had only reduced by 12 per cent. A 30 per cent increase in feed price resulted in a seven percentage point decrease in the IRR. This shows that although the production of CB hybrid requires higher capital investment, the long and short term profitabilities of the CB hybrid are higher than that of the channel catfish.

*Risk analysis for food size fish*

Figure 2 shows that the probabilities of negative average net returns for four hectares (10 acres) of channel catfish and CB hybrid are zero. It also shows that the production of CB hybrid food fish is more risk efficient than the channel catfish. For any risk level the NPV from the CB hybrid is much higher than that of the channel catfish. Hence the channel catfish food fish production is more risk dominant than CB hybrid.

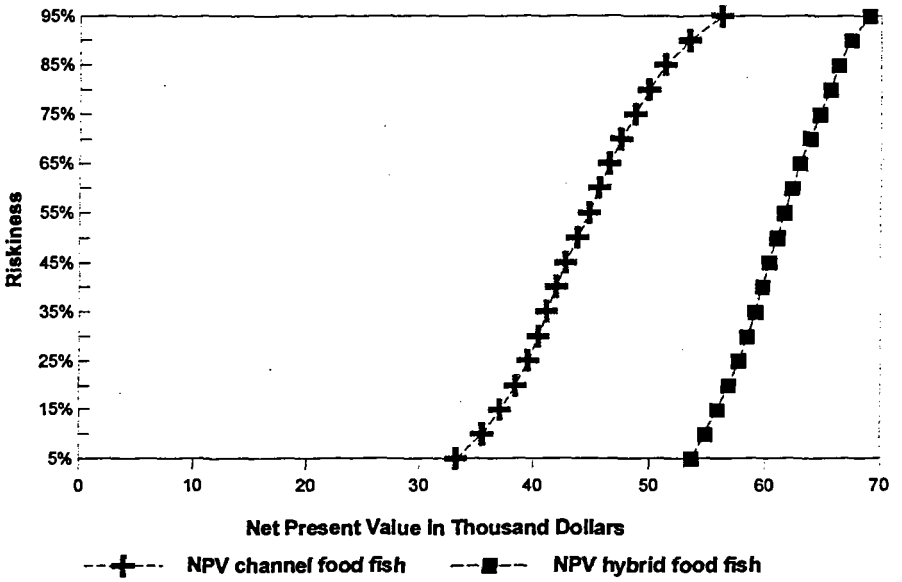


**Figure 2** Riskiness and net present value for 4-hectare (10-acre) ponds of hybrid and channel catfish food-size fish

## Summary

Utilization of channel catfish, *Ictalurus punctatus*, female x blue catfish, *I. furcatus* hybrid fry to produce fingerlings resulted in greater production, efficiency and profits compared to channel catfish. Total costs of production were 15.0-22.5 per cent less for hybrids even if hybrid fry were bought at a price twice as high as that for channel catfish. In the case where the farmer produced his own fry, cost of production for hybrids was 34.2-37.5 per cent less than channel catfish. Total costs were $32.73/1000 fingerlings and $43.92/1000 fingerlings for hybrid and

channel catfish fingerlings, respectively, when grown in a one hectare (2.5 acres) pond. Total costs were reduced about 40 per cent by using one hectare (2.5 acres), rather than 0.4 hectare (1.0 acre) fingerling pond.

The net returns to land, labor and management were $ 15020.30 per hectare ($6008.12/acre) and $3710.50 per hectare ($1484.2/acre) for hybrid and channel catfish fingerling production, respectively, assuming selling prices of $130/thousand and $100/thousand, respectively, with hybrid fry being purchased at double the price of channel catfish fry. If hybrid fingerlings are sold at the same price as channel catfish fingerlings, the net returns are still higher for hybrids, $8420.30 per hectare ($3368.12/acre).

The difference in net returns between hybrid and channel catfish fingerling production is likely underestimated. In 1996, the feed conversion rate, survival, production and body weight of the hybrids were 1.29, 100 per cent, 11,426 kg per hectare (10,055lbs./acre) and 40.4 kg per 1,000 (88.8lbs./1,000) fingerlings, compared to 1.58, 76.0 per cent, 5,212.50 kg per hectare, (4,587 lbs./acre) and 29.4 kg per 1,000 (64.6 lbs./1000) fingerlings for channel catfish. Despite a higher survival rate, the hybrids were still 37.4 per cent larger, and, therefore, should have commanded an even higher price. Another advantage of the hybrids was that their coefficient of variation was small for all parameters compared to channel catfish.

Production of food-size CB hybrid has been shown to produce positive net returns to land labor and management. The net returns to land, labor and management are superior to that of the channel catfish. On a two-hectare (five acre) pond, stocked with 15,250 fingerlings per hectare (6,100 fingerlings/acre), the net returns to land, labor, and management were $5,143.27 for the CB hybrid, compared to $4,432.05 for the channel catfish. The CB hybrid food fish production also generated higher NPVs and IRRs for two- and four- hectare (five- and ten-acre) ponds than the channel catfish. Variations in production and market parameters such as feed efficiency, mortality, prices of inputs and output from 10, 20, and 30 per cent did not affect the profitability of the CB hybrid. Risk simulated analyses showed that the probability of negative net returns to land, labor, and management and NPVs for the CB hybrid and the channel catfish for two-and four-hectare (five-and ten-acre) ponds approached zero. The results showed that the CB hybrid was more risk efficient than the channel catfish.

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